[PROC. ROY. SOC. VICTORIA, 36 (N.S.), PT. II., 1924.]

ART. X.—*The Geology of the Coimadai Area, Victoria. with special reference to the Limestone Series.*

BY ARTHUR L. COULSON, M.SC.

(With Plate XII., and 1 Text fig.)

[Read 13th December, 1923.]

Contents.

Introduction and Physiography.

The district, which is described and mapped, embraces portions of the parishes of Coimadai and Merrimu in the county of Bourke in the south central region of Victoria. It has an area of about 10 square miles and surrounds the village of Coimadai, which lies 6 miles north of Bacchus Marsh, which, in its turn, is 32 miles W.N.W. of Melbourne.

The three parallel creeks, Djerriwarrh on the east, Pyrete or Coimadai in the centre, and Goodman's on the west are the main streams. Along the sides of their valleys, river terraces, generally two in number, may be observed. Several tributaries occupy hanging valleys, and perhaps the best example is one which joins the Djerriwarrh about a mile south of the Melton Road bridge. This tributary flows east across the strike of the resistant sandstones of the Lower Ordovician series. The village of Comadai on the Pyrete Creek is situated in a basin which was probably formed while the creek was cutting a gorge for itself through the hard Ordovician sandstones in the extreme south of the area.

The important physiographic feature of the district is the Coimadai fault described by Hart and by Fenner[1]. It is a normal fault 5 to 6 miles long with a hade to the south. Its age is described as post-Older-Basaltic, but pre-Newer-Basaltic. Immediately to the west of the area it forms a boundary between Lower Ordovician rocks on the north and Permo-Carboniferous rocks on the south. Within the mapped area it probably changes its direction and swings to the north-east for a short distance with the outcrops of the Ordovician rocks and then dies out.

The eastern part of the area is a young plain in process of dissection. A prominent ridge exists between the Pyrete and Goodman's Creeks, and extends north and south beyond the limits of the area. It possesses a basalt capping which marks the course of the pre-basaltic river called the Bullengarook[2]. It is recorded that when the Bullengarook River was filled with basalt, the Pyrete and Goodman's Creeks arose, one on either side, and subsequently entrenched themselves in deep valleys.

Previous Work on the Area.

The oldest rocks of the area are the Lower Ordovician sediments. They belong to the Castlemaine horizon and have been described by Officer and Hogg[3] and by Harris and Crawford[4]. A glacial series of Permo-Carboniferous age rests on a glaciated surface of Lower Ordovician and it has been described by David[5], and by

1.—C. Fenner, "Physiography of the Werribee River Area," Proc. Roy. Soc. Vic., vol. xxxi. (n.s.), 1918, p. 236.
T. S. Hart, "The Highlands and Main Divide of Western Victoria." Proc. Roy. Soc. Vic., vol. xx. (n.s.), 1908, pp. 257-8.

2.—Fenner, op. cit., p. 248.
Harris and Crawford, "The Relationships of the Sedimentary Rocks of the Gisborne District," Proc. Roy. Soc. Vic., vol. xxxiv. (n.s.), 1921, pp. 42-44.
A. W. Howitt, "Notes on the Geological Structure of North Gippsland," Geol. Surv. Vic. Prog. Rpt., No. 4, 1877, p. 117.
J. Stirling, "Notes on the Bullengarook Plateau," Geol. Surv. Vic. Prog. Rpt. (n.s.), Nos. 8 and 9, 1899, p. 49.

3.—G. Officer and Hogg, "The Geology of Coimadai, Part II.," with appendices by C. W. De Vis, and T. S. Hall on the Marsupial Bones of the Coimadai Limestone and the Graptolites of the District respectively, Proc. Roy. Soc. Vic., vol. x (n.s.), 1898, p. 180.

4.—Op. cit.

5.—T. W. E. David, "Evidences of Glacial Action in Australia in Permo-Carboniferous Time," Quart. Journ. Geol. Soc., vol. lii., 1896, pp. 296-8.

Officer, Hogg and Balfour[6]. "Wightman's Rock" and "The Twins" are two noted glaciated pavements within the area.

The relations of the Cainozoic rocks—the limestones, gravels, and basalt—have formed the main purpose of this paper. In regard to these Officer and Hogg record[7] that the limestone series is overlain by a series of sands, gravels, quartzites and conglomerates, the bed superimposed on the limestone being different in different places. The limestone is not considered to occupy an erosion valley in the associated beds for two reasons (a) the superposition of the overlying beds and (b) the absence of fragments of grit, quartzite or conglomerate in the limestone or intercalated gravels. Two and a half miles below Coimadai they record a reversed sequence, finding in descending order basalt, limestone containing Limnaea and Bulimus, and clay, sand, and conglomerates, which merge into a quartzite. They disagree with Ferguson[8], who considers that there is an unconformity between the limestone and Miocene strata, and state that the limestone is part and parcel of the beds with which it is associated. In a road cutting near the above section they note, in descending order, gravel and sand, pipe clay with *Laurus werribeensis* (130 feet below the limestone level), and gravel and sand. They infer that the Coimadai series lies above the Bacchus Marsh Leaf Beds, which contain *L. werribeensis*, and that there is a gradual passage from the pipe clays into the overlying beds.

Their conclusions are as follow[9]: The Coimadai series is a freshwater one, fluviatile and lacustrine. The postulated lake occurred on Lower Ordovician and Glacial strata and had a large indentation sheltered from the main flow of the river where special conditions gave still water. The limestone is a dolomitic travertine, chemically precipitated from carbon dioxide springs. The irregular and patchy distribution is due to the local and intermittent character of the springs. Contemporaneous volcanic activity gave carbon dioxide, but the springs continued long after its cessation. Intercalated bands of sand and angular quartz gravels indicate that freshets occurred in the streams entering the lake and the few isolated bones were probably brought down by streams. The hard quartzites were formed by siliceous springs. The sediments filled the Coimadai basin and spread east over the more or less flat country extending to the Djerriwarrh Creek.

The views of Officer and Hogg have been stated at some length as they present the results of the most detailed investigation of the area. A statement of the views of other workers is as follows.

6.—Officer and Hogg, op. cit., pp. 181-196; G. Officer, L. Balfour and E. Hogg, Aust. A.A.S., Brisbane, 1895, pp. 321-330.

7.—G. Officer and Hogg, "The Geology of Coimadai, Part I," Proc. Roy. Soc. Vic., vol. x (n.s.), 1897, p. 65.

8.—W. H. Ferguson, "Notes on the Occurrence of Limestone at Merrimu," Geol. Surv. Vic. Prog. Rpt., No. 8, 1894, pp. 69-70.

9.—Op. cit., pt. i., pp. 68-70.

Dunn[10] says that the limestone forms an isolated hill. It occurs in thick beds with thin partings of shale, 1 to 2 inches thick containing abundant plant remains. He mentions that the beds dip in all directions, and puts their probable age down as Pliocene.

Brittlebank[11] says that a considerable period of time elapsed between the deposition of the Miocene and the flow of newer basalt as is shown by the depth of the old river channels. He draws attention to the absence of dykes of new basalt through the Miocene, contrary to his expectations.

Murray[12] advocates the view that the limestone is of Tertiary age and is either of freshwater origin or a spring deposit. It covers an area of 24 acres.

Description of the Kainozoic Rocks.

(*a*) *Limestone Series.*

Chemical Characters.—The Coimadai limestone is of commercial importance on account of its hydraulic properties and is worked at Alkemade's, Burnip's, and Hjorth's quarries. Its magnesian character is shown by the following three analyses:

	I.		II.		III.
SiO_2	0.55	–	0.69	–	2.33
Al_2O_3 . . .	nil	–	0.12	–	1.59
Fe_2O_3 . . .	2.07	–	1.55	–	15.91
MgO	20.37	–	19.17	–	15.96
CaO	29.74	–	31.30	–	24.46
CO_2	—	–	43.52	–	36.19
H_2O- . . .	—	–	—	–	1.08
H_2O+ . . .	—	–	—	–	1.88
Ignition loss .	46.39	–	—	–	—
	99.12	–	99.59	–	99.40
Moisture at 100° C. . . .	0.32	–	0.31	–	—

I. Dolomite, Coimadai[13].
II. Limestone, Coimadai[14].
III. Dolomite, specimen No. 45, Hjorth's quarry, Coimadai, Analyst, A. L. Coulson.

10.—E. J. Dunn, "Notes on Some of the Geological Formations near Bacchus Marsh," Rep. and Stat. Min. Dept. Vic., for 1910, p. 26.
11.—C. C. Brittlebank, "Notes on So-Called Miocene Deposit of Bacchus Marsh," Vic. Nat., vol. xiii., No. 6, 1896, pp. 83-4.
12.—R. A. F. Murray, "Report on Limestone Quarries in the Bacchus Marsh District," Geol. Surv. Vic., Mon. Prog. Rpt. (n.s.), Nos. 8 and 9, 1899, p. 51.
13.—H. C. Jenkin, "Report of the Government Metallurgist for 1900," Ann. Rept. Sec. Mines, Vic., for 1900, p. 37.
14.—Op. cit., p. 38.

No. III. contains CaO, MgO, and CO_2 in practically the correct proportions for a dolomite. It is also a very ferruginous variety in comparison with the previously recorded analyses.

Officer and Hogg[15] record the following beds in descending order in Alkemade's quarry:

1. Gravel and ferruginous conglomerate, 8 feet.
2. Very fine blue clay, interspersed with finely laminated limestone shales with lenticular masses of hard limestone, 10 feet.
3. Yellowish limestone, soft, but containing bands of hard limestone, 6 feet.
4. Thin ash bed, 6 inches. This varies in thickness from 2 inches to a foot and has a wide distribution on both sides of the valley.
5. Yellowish white limestone, honey-combed in places, 6 feet.
6. Gravel and calcareous sand, 12 to 15 inches.
7. Calcareous sand, usually soft, containing mammalian bones, 3 feet.
8. Grit, sand, and gravel, calcareous, 1 foot 8 inches.
9. Soft earthy, gritty limestone, with lenticular masses of hard compact stone, 6 feet.
10. Hard compact limestone, very fine-grained in places, gritty in others, fawn, bluish, white, ? 26 feet.

The total thickness is thus about 70 feet. There is a considerable amount of distortion in the beds. Subsidence of the overlying clay beds follows the removal of any portion of the limestone bed. It is probable that the sagging down of the clay bands would keep pace with the solution of the limestone.

Microscopical Characters.—Many sections have been made of the limestones, particularly those of Alkemade's and Hjorth's quarries, and in all cases they are dolomitic

Specimens from Hjorth's quarry are light yellow in colour and prove to be exceedingly fine-grained under the microscope. The larger crystal grains resemble dolomite rhombohedra. Some specimens are comparatively free from iron, while others with a deeper colour contain both limonite and hematite, as in the analysed specimen, No. 45. In one case (No. 51) there are minute globules of iron oxide, concentrically arranged, and suggestive of xanthosiderite. In the same rock there is a suggestion of organic remains in certain curved bodies which are abundant. In a section through a concretion in the limestone the grains appear to be more scalenohedral than rhombohedral and are probably more calcitic than in the typical dolomitic limestone.

The most interesting specimens (Nos. 53, 70, 71) were obtained from a bed in Alkemade's quarry, 4 feet below the ash bed, in the north wall of the quarry. It is rather a peculiar type, being somewhat like a mudstone, though a little harder. It shows a laminated

15.—Officer and Hogg, op. cit., part I., pp. 62-4.

character and is extremely fine grained. In places there are little lenticular shaped masses of calcite or dolomite, around which the laminae are curved, showing the lenticles to be of primary origin. With cold dilute acid there is a moderate effervescence and the test with Lemberg's solution shows the presence of calcite. The rock contains numerous grains, usually circular in shape, which vary in number in the different bands. The fact that some are not definitely circular in outline and are indented along the edges suggests their organic origin. Through the courtesy of Miss Cookson, of the Botany Department of the University, the grains in the sections were compared with pollen grains of various flowering plants, and in size and other particulars they agree in some respects with those of *Pinus*. The comparison would, however, have to be carried out on native Australian plants. The grains sometimes have a quadrate centre, while some seem to be composed of four segments. They always have an outer wall. In a section cut parallel to the bedding planes (No. 70) there is a suggestion of spines and wings very similar to pollen grains. Scattered through the section are a few grains of quartz and some chalcedonic silica.

A nodule of concretionary limestone occurring just above the lowest compact limestone of Alkemade's quarry is much harder than the usual dolomitic variety. It is brownish white in colour and contains small fragments of detrital quartz, shale and quartzite, which are set in a fine-grained groundmass, composed of minute scalenohedra of calcite. In another example of dolomitic limestone the majority of the grains are dolomitic rhombohedra, from which the central core seems to have been removed. Some of these are more circular than rhombohedral, and suggest organic remains, but are too minute to be diatoms. In a further variation of the limestone, limonite occurs as pseudomorphs after pyrite, while in one instance the individual crystal grains are of the nature of zoned rhombohedra with curved faces.

Ochres.—Pocket-shaped masses of "ochres" are found in the limestone in the three quarries and vary in colour from red to yellow. A sample of impure red ochre was obtained from the south-east corner of Alkemade's quarry, where it forms small lenticular shaped masses. The material is extremely soft and porous and, when examined under the high power, it is seen to consist of minute rhombs of dolomite, with an outer edge of limonite or hematite embedded in fine-grained calcite. The iron is probably derived from the decomposition of siderite and the varying stages in the alteration of the siderite to limonite or hematite correspond with the changes in colour from a yellow to a deep red. The ochre is essentially a carbonate, as with cold dilute hydrochloric acid, the average loss, after standing for an hour, was 88.6%.

A sample of "yellow ochre" from the east wall of Hjorth's quarry is finer grained than the preceding, and more dolomitic. Its colour is due to numerous globular grains of limonite, while there are a few rectangular crystals of hematite, possibly pseudomorphs after pyrite.

Ash Bed.—The ash bed, which occurs in the three quarries, is a valuable bench mark. Its origin has been confirmed by the microscopical examination. It is a yellowish coloured rock which is extremely friable in Hjorth's and Burnip's quarries, but considerably harder in Alkemade's. Under the microscope, quartz is the most abundant mineral present. Biotite and felspar occur together in fragments, but the nature of the latter is indeterminate. Radiating aggregations of an unidentified colourless mineral with straight extinction, high refractive index, and low polarisation colours can be seen. Picotite, monazite, with high polarisation colours, and pyrite occur occasionally. Numerous pieces of slate, shale, sandstone, etc., can be identified.

In the harder rock (No. 54) from Alkemade's quarry, the quartz grains nearly all show irregular cracks and a rounded outline. Twinned crystals of plagioclase are recognised in the igneous fragments, but picotite is less frequent. A minute cellular structure is also observed which confirms its volcanic origin. It seems likely that the deposition of ash fragments and of sediment has occurred from simultaneous processes.

(*b.*) *Upper Cainozoic Gravels, Sands, etc.*

These cover a large part of the area and are variable in nature. In places the gravels are cemented by silica giving quartzites, grits, etc., and in others by ferruginous matter giving ferruginous grits, etc. Sometimes a calcareous cement is present. The lowest gravels are extremely coarse, containing large blocks of the ancient bedrock and resemble torrential river deposits. The ironstones yield a large amount of buckshot gravel and occur at a higher level than the coarse deposits, forming the flat country on the eastern side of the area near the Djerriwarrh Creek.

The ironstones are variable and an example from allotment 11a, Merrimu, is a fairly hard reddish type. It consists of angular and rounded grains of quartz in a matrix of limonite and hematite, together with a few small flakes of muscovite.

The ferruginous sands from allotment 9B, Merrimu, show gradations from a dark red ironstone to a white quartzite. A dark variety consists of rounded quartz grains and occasional flakes of muscovite, cemented by ferruginous matter from percolating solutions. The general appearance of the quartz grains is rounded, but evidence of attack is observed under the high power, and the margins are corroded. The iron oxide appears sometimes as minute globules which may be xanthosiderite. In a quartzite from the same locality the cement is silica. As in the ferruginous sands, the grains are corroded along the edges, while some have been recrystallised to a polysynthetic mosaic.

In a soft sandstone occurring immediately under the basalt in allotment 4B, Coimadai, occasional muscovite, light green tourmaline and zircon are observed in addition to the quartz. In another sandstone under the basalt at the corner of Coimadai and Bullengarook roads, a considerable amount of kaolin indicates a felspathic type. Below this sandstone are ironstained sands which pass into very fine incoherent sands with beds of intercalated pipe clay. The sands are used commercially. Occasional small crystals of tourmaline and zircon are detected under the microscope and it is probable that the deposits are lacustrine.

(c) *Monchiquite Dykes.*

Monchiquite dykes are exposed along the bed of Goodman's Creek where they are intrusive into Permo-Carboniferous beds. They do not come into contact with the basalt or the gravels, but are likely to be of the same age as the monchiquite dykes of Daylesford which appear to be pre-Newer-Basaltic. A group of six occur about ¾ miles south of the junction of Back and Goodman's Creeks. A little north of this group are two more, one of which is very decomposed. The other, being relatively fresh, was sectioned. It is 18 inches wide and trends N. 88° E.

The hand specimen is dark and heavy and shows numerous phenocrysts of olivine. Under the micrcoscope olivine and augite occur as phenocrysts, the former being extensively altered to serpentine. Black grains of ilmenite, rectangular prisms of a titaniferous augite, together with a brown glass, form the groundmass of the rock. Secondary calcite is common and felspar is absent.

(d) *Basalt.*

The source of the basalt is probably Mount Bullengarook. North of the area it has been estimated to be 250ft. thick and 300ft. wide, but it narrows to 40ft. wide and 3ft. thick at a place known as "The Neck." Southwards from this, it widens and increases in thickness to about 40ft. Its nature[16] is usually that of an olivine basalt though magma basalt and limburgite occur, the latter towards the north. The minerals present are labradorite, augite, secondary calcite, magnetite and a light brown glass.

At the junction of Coimadai and Bullengarook roads angular fragments of sandstone are embedded in the basalt. The junction of the basalt and the inclusions is marked by an irregular line of minute pyroxene crystals. In a few places in one example (No. 41) the pyroxene crystals are arranged at right angles to it. Many minute crystals of ilmenite are interspersed along the reaction rim and the quartz of the sandstone is corroded and penetrated by the pyroxene crystals. A dark red mica, occurring in small flakes, has been developed in the sandstone, and olivine has been entirely altered to iddingsite.

16.—Officer and Hogg, op. cit., pp. 70-4.

General Discussion of the Problem of the Limestones, Gravels and Basalt.

Age of the Limestone.—The fossils described from the limestone series by De Vis[17] are:

Phascolomyidae: *Phascolomys parvus*, (Owen).

Macropodidae: *Macropus (Halmaturus) dryas*, (De Vis). *M. anak*, (Owen). *M. cooperi*, (Owen).

Nototheriidae: Several bones not referred to any definite genus.

The vegetable fossil remains consist of fragmentary grasses and characeous plants. These fossils, both animals and plants, are all referable to the Pleistocene, in which series, chiefly in Queensland, similar fossils have been found. A Pleistocene age is therefore assigned to the limestone series, which has been variously referred to as Lower Tertiary[18], Miocene[19], and Pliocene[20].

Formation of the Limestone Basin.—The occurrence of the Coimadai fault had a very profound effect on the drainage system of the area. The pre-Newer-Basaltic stream known as the Bullengarook River, was rejuvenated by it, and a direct result was the deposition of a mass of very coarse torrential material and the formation of the lowest gravels over the relatively sunken area to the south. Later the river gradually regraded itself by headward erosion from the fault scarp, and fan deltas came into existence and finer material was deposited.

Eventually the Bullengarook River filled up the area south of the fault scarp with a mass of incoherent gravels, through which it carved for itself a broad open valley. The uneven surface of this material was possibly accentuated by further movements along the fault plane. It may be supposed that with the collection of water in the irregularities of the surface a quiet lake developed, with little or no sediment from the main river, which had reached a state of old age in Pleistocene times. The development of the lake was possibly assisted by the damming of the river, in its southern part, by one of the earlier flows of newer basalt.

Development of the Limestone and Gravels.—The series under consideration is purely a local one and there are no known older dolomitic rocks in he neighborhood. It is clearly, therefore, not an example of the clastic method of dolomitic formation.

The uniform extreme fineness of grain in all examined specimens and the absence, with one or two possible exceptions, of calcareous organisms, suggest its derivation as a chemical precipitate. In addition, however, there has been, as in No. 58, solution of the

17.—Officer and Hogg, op. cit., pt. ii., pp. 198-201. C. W. De Vis, "Review of the Fossil Jaws of the Macropodidæ in the Queensland Museum." Proc. Lin. Soc., N.S.W., vol. x., 1895, pp. 75-133. R. Owen, "Researches in the Fossil Remains of the Extinct Mammals of Australia," 1877, Erxleben.

18.—Ferguson, op. cit., p. 70.

19.—Officer and Hogg., op. cit., pt. i., pp. 66, 67.

20.—Dunn, op. cit., pp. 26, 27.

central core of the zoned rhombohedra. This suggests that the central core was different chemically (probably calcite) to the outer rim and that, subsequent to its precipitation, there has been differential leaching of a slightly magnesian limestone. It is therefore, likely that the Coimadai dolomitic limestone is the result of two processes, viz., the deposition of a chemical précipitate of magnesian limestone, and the differential leaching, in places, of this precipitate giving a more magnesian limestone.

The formation of the "ochres" involves secondary alteration of the limestone, for an outer zone of siderite in rhombic sections is altered to limonite and hematite.

The chemical precipitate and the development of quartzites and ironstones, etc., from the incoherent gravels may be accounted for by springs containing calcium, magnesium and iron salts, and also carbon dioxide and silica, in solution. This is in general agreement with the views of Officer and Hogg. As these springs entered the quiet lake, a condition of saturation would quickly develop, if the amount of water lost by evaporation exceeded that flowing into the basin. Further evaporation would cause the deposition from solution of the carbonates of lime and magnesia, while local concentrations of iron oxide and iron salts might be expected. The precipitated matter should, therefore, roughly correspond to the shape of the basin, accounting for the observation that all the limestone beds dip centrally.

When the spring waters percolate through the gravels their resultant effects are great, but naturally very sporadic and variable.

As the normal state of quiescence in the lake became disturbed by flood waters, small amounts of sand and gravel were intercalated among the limestone beds. The few mammalian bones, which are confined to these sandy beds, were transported in this manner, and with a reversion to the quiet conditions, the precipitation of the limestone would continue. Very quiet conditions are indicated by the preservation of the delicate casts of pollen grains showing the structures of spines and wings.

Basaltic lava flows followed the sedimentation in the lake, but were preceded by the outburst of a fine ash, which has only been preserved in the limestone lake. Officer and Hogg do not connect the ash bed of the quarries with the outflowing of the basalt, but it seems a logical correlation as Brittlebank[21] has noted an ash band in the Parwan Creek basalts, not very far distant. Assuming a relation between the two, the limestone must be geologically younger than part of the basalts, which can then be placed as Pleistocene. In this case the lava flow from Mt. Bullengarook filled the valley of the old Bullengarook River without affecting the limestone lake where the deposition from solution continued. The basalt is quite similar to the newer basalts of the Western

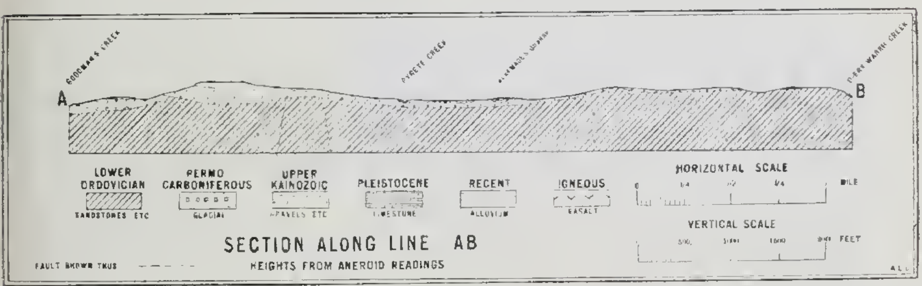
---

21.—C. C. Brittlebank, op. cit., p. 84.

district and the Melbourne area, whose age is considered by Professor Skeats to vary from the Pliocene to recent[22].

The outpouring of basalt completely altered the drainage system of the area. Pyrete and Goodman's Creeks came into existence and deposited, in their initial stages, high level gravels as a capping over the older rocks. In deepening their channels they carried away much of the soft gravel deposit of the old Bullengarook River, destroyed the limestone lake and removed most of the limestone. The whole of the limestone deposit was not destroyed and the remnant is now covered by the higher level gravels of these streams.

The beds of Hjorth's quarry dip north into the valley at a slightly greater angle than the slope of the surface gravels, which are here five or six feet thick. Precisely the same occurs at Alkemade's and Burnip's quarries, the beds dipping south in the latter case. In consequence Ferguson[23] infers a strong unconformity between the "Miocene" strata and the limestone series, while, according to the above theory, the surface gravels are considered to be the debris or hill wash of the higher level gravels of the Pyrete Creek.



In the above hypothesis the gravels are not regarded of one age, but range from Miocene to Recent. They are mapped as Miocene by the Geological Survey of Victoria[24]. Howitt[25] and Ferguson[26] place them as Miocene, while Officer and Hogg state that the Miocene gravels, to the south of the area, grade up into the sands and gravels in question and they map the latter as Miocene.

In the accompanying map (Plate XII.) there are several minor alterations of the geological boundaries, compared with the earlier maps. The roads and allotment boundaries are taken from the parish plans of Coimadai and Merrimu. The chief point of divergence between this map and the unpublished quarter-sheet of the

22.—E. W. Skeats, "The Volcanic Rocks of Victoria," Pres. Add., Sec. C, Aust., A.A.S., Brisbane, 1909, p. 209.

23.—Op. cit., p. 69.

24.—Quarter sheet No. 12, N.E. (unpublished).

25.—Op. cit.

26.—Op. cit., pp. 69-70.

Geological Survey, a copy of which was obtained through the courtesy of Mr. D. J. Mahony, M.Sc., and Mr. W. E. Bennett, is in the boundary of the Upper Kainozoic gravels with the Lower Ordovician near the Coimadai Road, running E.S.E., from its junction with the Bullengarook Road, to the Pyrete Creek. The chief difference from Officer and Hogg's boundaries of the Ordovician and the Upper Kainozoic gravels occur in the north west corner, near Goodman's Creek, and in the north central area north east of Burnip's quarry. The mapping of the eastern part of the area along Djerriwarrh Creek is new. The fault marked on the map is the approximate position of the Coimadai fault.

Summary and Acknowledgments.

The area surrounding the village of Coimadai has been remapped and the relations of the Tertiary series have been studied. Many sections of the limestones and gravels have been examined microscopically and one specimen analysed. A laminated limestone containing fossil pollen has been described and the occurrence of an ash bed has been confirmed.

The earliest of the gravels are probably of Miocene age. Previous workers have placed the age of the Comadai fault as pre-Newer-Basaltic and post-Older-Basaltic, and have claimed that the Miocene gravels south of the area pass up into the sub-basaltic series. Owing to the impossibility of distinction between the various gravels in the field, they are classed as Upper Kainozoic in the accompanying map, this term signifying a range from Miocene to post-Pleistocene.

The limestone series is placed as Pleistocene. Its deposition occurred at the same time as the formation of the quartzites, conglomerates, ironstones, etc., in the adjacent gravels. The sub-basaltic sands and limestone are placed on the same horizon as the quarry limestones. Later than these are the sands and gravels of the Djerriwarrh Creek area.

The limestone is considered to have been chemically precipitated just before, during, and after the Bullengarook lava outburst, in a small local basin which probably owed its origin to unequal consolidation of the gravels.

In conclusion the writer wishes to record his most grateful thanks, to the following: Professor E. W. Skeats, for much assistance in the nature of criticism and advice throughout the course of the work; Associate-Professor H. S. Summers, for many helpful suggestions and discussions; and Mr. F. Chapman, for pointing out the presence of pollen grains in the limestones.

EXPLANATION OF PLATE.

Plate XII.—Geological Sketch Map of Coimadai.